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Testing the Effects of Attention Training at Later Stages of Processing Among Socially Anxious Individuals: a Web-based Randomized Controlled Trial

Taylor Davine
University of Wisconsin-Milwaukee

TESTING THE EFFECTS OF ATTENTION TRAINING AT LATER STAGES OF PROCESSING AMONG SOCIALLY ANXIOUS INDIVIDUALS: A WEB-BASED RANDOMIZED CONTROLLED TRIAL

by

Taylor Davine

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ABSTRACT

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Taylor Davine

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Attention bias (AB) modification training is an emerging intervention for the treatment of social anxiety disorder. Research has shown that attenuation of AB leads to reductions of social-anxiety symptoms. To date, researchers have relied primarily on the AB modification paradigm that is designed to improve disengagement from threatening stimuli at early stages of attentional processing. Numerous AB modification studies have demonstrated that individuals who show reductions in AB to threat also show improvement in clinical outcome (e.g., diagnosis, symptoms). These studies provide support for the theory that AB may be a mechanism that causes and/or maintains emotional disorders such as anxiety and depression. Given the recency of AB modification as a therapeutic intervention, it is not surprising that not much is known about how or under what circumstances AB modification is effective. Thus, for the present study we tested whether the addition of a late-stage training component could improve the existing AB modification paradigm that exclusively focuses on early attentional disengagement from threat. Individuals who reported significant symptoms of social anxiety were randomized to one of three conditions: (1) AB modification aiming to improve attentional disengagement from threat at early stages (500ms), (2) AB modification aiming to improve attentional disengagement from threat at early stages

(500ms) and reduce attentional avoidance at later stages (3,000 ~ 5,000ms), and (3) placebo control. We hypothesized that, relative to the existing AB modification or placebo condition, the AB modification condition with an additional training component focused on reducing attentional avoidance at late stages will show greater clinical improvements. Overall, the data were trending in expected directions with small to moderate effect sizes, which suggests the possibility that the addition of a late-training component may increase the efficacy of the existing AB modification. Future investigations using a larger clinical sample is warranted to further investigate how AB modification can be optimized for improved clinical benefits.

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Testing the Effects of Attention Training at Later Stages of Processing among Socially Anxious Individuals: A web-based Randomized Controlled Trial

Social anxiety disorder (SAD) is a debilitating psychiatric condition with an estimated 12-month prevalence rate of 6.8% (Kessler, Chiu, Demler, & Walters, 2005) and an estimated lifetime prevalence rate of 12.1% (Kessler et al., 2005). Many more individuals experience social-anxiety-related symptoms but do not meet full criteria for the disorder. SAD is characterized by an excessive fear or anxiety of being observed or evaluated by others. Individuals with SAD fear that they will say or do something embarrassing that will lead to negative judgment. The type of social situations that evoke anxiety vary; however, some common situations include conversing with a stranger, attending a party, speaking in public, and talking to authority figures.

SAD is a chronic disorder that emerges during adolescents (Kessler et al., 2005). The average duration of the illness is between 19 and 30 years, with recovery rates estimated between 27% and 52% (Chartier, Hazen, & Stein, 1998; Davidson, Hughes, George, & Blazer, 1993; DeWit, Ogborne, Offord, & McDonald, 1999; Kessler, Stein, & Berglund, 1998). Those with SAD may avoid social situations or endure social situations with discomfort and/or help from others. The symptoms associated with SAD (e.g., fear, avoidance, withdraw) often lead to negative functional outcomes. Compared to individuals without the disorder, those with SAD are more likely to have impaired family relations (Schneier, et al., 1994), and impaired friendships (Davila & Beck, 2002; Sparrevohn & Rapee, 2009). A diagnosis of SAD is also associated with financial difficulty (Schneier, Johnson, Hornig, Liebowitz, & Weissman, 1992) and underemployment (Wittchen, Fuetsch, Sonntage, Müller, & Liebowitz, 2000). Finally, individuals with SAD are likely to meet diagnosis for an additional psychiatric disorder, often another anxiety disorder and/or depressive disorder (Fehm, Beesdo, Jacobi, & Fiedler, 2008).

Current Treatments for SAD

Current treatments for SAD have demonstrated efficacy and effectiveness across numerous clinical trials. The primary treatment for SAD is cognitive-behavioral therapy (CBT) and/or medication (Rodebaugh, Holaway, & Heimberg, 2003). CBT is an umbrella term that includes treatments such as exposure training, skills-training, and cognitive restructuring. Mayo-Wilson and colleagues (2014) published a review of 101 clinical trials consisting of 13,164 participants. They reported that individual CBT was the best intervention for the initial treatment of SAD, and selective serotonin reuptake inhibitors (SSRIs) were the best medication treatment for those who decline or did not respond to psychotherapeutic intervention. Further, they reported that the combination of CBT and medication produced, generally, large effects sizes. Certainly, progress has been made in the treatment of SAD; however, many individuals will not respond to treatment and remain affected. Further, a review by Gould, Buckminster, Pollack, Otto, and Massachusetts (1997) highlights the variability of retention that exists between intervention modalities. They reported that drop-out rates of CBT-based intervention ranged from approximately 10% (social skills training) to 50% (systematic desensitization), and drop-out rates from pharmacological intervention ranged from 0% to 35% among individuals who received an active medication. Finally, it has been reported that many forms of CBT (e.g., exposure, social skills training, cognitive restructuring) are effective in reducing social anxiety symptoms (e.g., Canton, Scott, &

Glue, 2012). Taken together, aforementioned findings support the premise that divergent therapeutic techniques can produce similar positive outcome in the treatment of SAD. However, this also highlights the importance of further research to elucidate which treatments are most effective for specific individuals.

Attention Bias

To improve in the treatment of SAD, significant attention has been directed toward the cognitive mechanisms that underlie the disorder. One area that has garnered significant interest and support is attention bias (AB). Given that the human information processing network has a limited capacity to receive and process information, allocation of attention is also limited (McNally & Reece, 2009). Thus, AB is conceptualized as dedicating a greater amount of attentional allocation to one type of stimuli than another. Most research demonstrates that anxious individuals show an AB toward threating stimuli relative to non-threatening stimuli. A review of 172 AB studies conducted by Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, and van IJzendoorn (2007) reported a medium AB to threat effect size of d = .45. Given the robust presence of AB in anxiety disorders, many cognitive models of attention account for this phenomenon (Beck & Clark, 1997; Eysenck, Derakshan, Santos, & Calvo, 2007; Mathews & Mackintosh, 1998; Mogg & Bradley, 1998; Öhman 1996; Wells & Matthews, 1994; Williams, Watts, MacLeod & Mathews, 1988). While the effect of AB to threat is robust, some ambiguity exists as to the subcomponents of AB.

There is a significant amount of research that suggests that anxious individuals have an AB for threat-related information (e.g., Bar-Haim et al., 2007). Currently, there are three patterns of AB that are prominent in the anxiety literature: (a) vigilance, (b) avoidance, and (c) vigilance followed by avoidance. The vigilant pattern of AB is characterized by the propensity to attend to threat cues relative to non-threat cues. Vigilance can occur at early (e.g., automatic) stages of information processing and later stages (i.e., intentional). Conversely, the avoidant pattern of AB occurs when an individual directs attention away from potential threat cues (Chen, Ehlers, Clark, & Mansell, 2002; Mansell, Clark, Ehlers, & Chen, 1999). In an effort to explain the paradoxical nature of the vigilance and avoidance pattern of AB, researchers developed more sophisticated models of AB and have suggested that socially anxious individuals initially orient attention toward threat cues, followed by avoidance away from threat cues (Clark & Wells, 1995; Mogg et al., 1998).

AB Assessment Paradigms

AB is commonly measured using reaction time indices during experimental tasks, such as the emotional Stroop, spatial-cueing task, and the modified dot-probe. In the emotional Stroop paradigm (Mathews & MacLeod, 1985), individuals are presented with emotionally valenced words: negative (e.g., angry), positive (e.g., happy), and neutral (e.g., pencil). Individuals are instructed to name the color of the word as quickly and accurately as possible, while ignoring the meaning of the word. For instance, an AB to threat is inferred when response latency is faster for trials presenting negatively-valenced words relative to positively-valenced or neutral words. Generally, individuals with an anxiety disorder show greater levels of Stroop interference than healthy controls, suggesting an AB toward threat among individuals with social anxiety disorder (Hope, Rapee, Heimberg, & Dombeck, 1990), generalized anxiety disorder (Mathews & MacLeod, 1985), obsessive compulsive disorder (Foa, Hai, McCarthy, Shoyer, &

Murkock, 1993), panic disorder (Ehlers, Margraf, Davies, & Roth, 1988), and posttraumatic stress disorder (McNally, Kaspi, Riemann, & Zeitlin, 1990). Although, some researchers have failed to replicate this effect in posttraumatic stress disorder (Freeman & Beck, 2000), panic disorder, and obsessive compulsive disorder (Kampman, Keijsers, Verbraak, Näring, & Hoogduin, 2002). Some researchers also raised the issue of ambiguity of the mechanisms involved in Stroop interference (e.g., attentional shift, captured attention vs. task disruption), making its validity as an attentional measure questionable. This prompted researchers to devise and test more sophisticated methods of assessing AB.

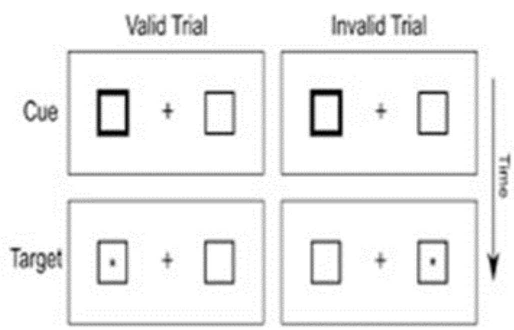

Figure 1. Posner-cueing task.

A modified version of the spatial-cueing task (see Figure 1; Fox, Russo, Bowles, & Dutton, 2001; Posner, 1980) was developed in order to test different facets of attention, particularly attentional shifting, engagement and disengagement. In this task, individuals are presented with a cue (e.g., face, word) that appears on a computer screen in one of two target locations. Cue valence is manipulated; negative-valence (e.g., sad facial expression), positive valence (e.g., smiling facial expression) and neutral (e.g., neutral facial expression). A target probe (e.g., E, F) appears shortly after the presentation of the cue (e.g., 500 ms) in one of the two target locations. A valid trial is one in which the target probe follows in the location of presented cue; conversely, an invalid trial is one in which the target probe follows in the location opposite of the presented cue. Two indices of AB are calculated for this task. Attentional engagement (i.e., facilitated attention) is inferred when reactions times are faster for valid-threat trails relative to valid-neutral trails. Attentional disengagement (i.e., difficulty disengaging from threat) is inferred when reaction times are faster on invalid-neutral trials relative to invalid-threat trials.

To date, a large amount of AB research has been conducted using a modified version of the dot-probe (see Figure 2), a computerized task developed by MacLeod, Mathews, and Tata (1986). In this task, individuals are asked to fixate on a cue (e.g., '+') for a short duration. Then, two stimuli (e.g., words or faces) are presented side-by-side or one above the other. Various combinations of stimuli are presented (e.g., neutral-threat, neutral-neutral) to assess reaction time differences in detecting/identifying the probe (e.g., E, F) that follows the paired stimuli as a function of cue-valence. An AB to threat is inferred when reaction times are faster during trials in which the target probe replaces the location of threating stimuli relative to the positive or neutral stimuli.

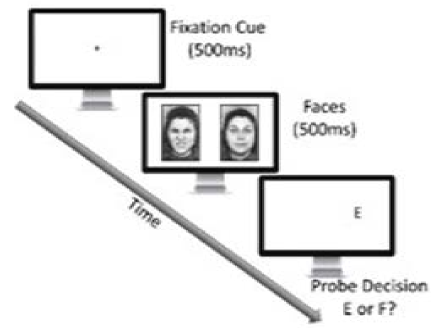

Figure 2. Modified dot-probe task.

Recent advancements in computer technology (i.e., eye-tracking) provide an alternative method to assessing AB. Mogg, Philippot, and Bradley (2004) conducted an eye-tracking study with socially anxious individuals. They reported that socially anxious individuals were more likely to show an AB to angry faces than to happy or neutral faces during 500 ms of stimuli presentation; however, at 1250 ms of stimuli presentation no biases were present. This finding contradicts a recent review by Armstrong and Olatunji (2012) who examined 33 studies (N = 1579) that used computerized eye-tracking to assess AB in anxiety and depression. They concluded that during visual search tasks, relative to controls, anxious individuals showed an early vigilance to threat followed by difficulty in disengaging from threat. These mixed findings highlight the need for additional research in this area.

AB modification

The wealth of research showing a relationship between AB and anxiety-related symptoms was the impetus to develop and test whether AB is a causal factor to anxiety-related outcome. If a causal relationship does exist, then manipulation of AB should produce changes on anxiety symptoms. MacLeod, Rutherford, Campbell, Ebsworthy, and Holker (2002) created an AB modification program using the dot-probe task. In the study, non-anxious individuals were trained to attend toward threatening stimuli or away from threatening stimuli, by way of probe-placement (e.g., probe appears in the location away from threat). They found that individuals developed an AB relative to their respective condition. Additionally, those who were trained to attend to threat reported more anxiety and depression during an experimental stress task (i.e., unsolvable anagrams while being video recorded) than individuals who were trained to attend away from threat. This result was supported by Amir, Weber, Beard, Bomyea, & Taylor (2008) who used a single-session AB modification training to assess changes in AB and clinical outcome in SAD. They found that changes reductions in AB to threat were associated with reductions in social-anxiety symptoms. Further, they found that participants who were in the AB modification condition were rated more favorably than those in the placebo control during a speech task. These promising findings have been replicated among treatment seeking individuals with generalized anxiety disorder (Amir, Beard, Burns, & Bomyea, 2009) and generalized social anxiety disorder (Schmidt, Richey, Buckner, & Timpano, 2009). While AB modification shows promise, some researchers have criticized extant findings. For instance, Emmelkamp (2012) points to a lack of evidence demonstrating a link between AB modification and clinical outcome, subsequently putting into question therapeutic validity. Additionally, there are several AB modification studies that have failed to attenuate AB or clinical symptoms among socially anxious individuals to a greater degree than a placebo control condition (Boettcher, Berger, & Renneberg, 2012; Boettcher et al., 2013; Bunnell, Beidel, & Mesa, 2013). Nevertheless, a recent systematic review of Clarke, Notebaert, and MacLeod (2014) indicate that most studies demonstrating null findings (i.e., no superiority of AB modification over placebo control) did not succeed in reducing attentional bias toward threat, whereas most studies displaying clinical benefits of AB significantly reduced the magnitude of AB. More specifically, they indicated that 26 of 29 AB modification studies (=90%) resulted in positive clinical changes when AB was modified. Therefore, despite the presence of mixed findings, the theoretical assumption underlying AB modification (i.e., symptom improvement when AB is reduced) still holds across the rapidly growing literature.

Limitations of exiting AB modification procedures

AB modification as a treatment for anxiety-related disorders shows promise; however, there is still much to learn. A significant limitation of current AB modification procedures is that most studies have exclusively examined changes of AB at early stages of attentional processing (i.e., 500 ms). Examining the effects of later stages of processing is important to elucidate the time-course trajectory of AB. Implications from such study designs will further the development and efficacy of AB modification programs. As reviewed above, despite the theoretical consistency of the AB modification findings, it is a critical limitation of this novel intervention that its effectiveness in altering the magnitude of AB has been shown to be quite inconsistent. There is a crucial need to further improve the design of existing AB modification to improve its capability to therapeutically modify attentional processes in response to threatening stimuli.

There is emerging evidence to suggest that the pattern of AB changes over time. For instance, Mogg and colleagues (2004) reported that an AB to angry faces was present at 500 ms but not 1250 ms. Furthermore, Koster, Baert, Bockstaele, and Raedt (2010) found that individuals' AB to threat was reduced at a later stage of processing (i.e., 1500 ms) but not early stages of processing (30 ms, 100 ms). There is, however, no research that has tested an AB modification training intended to address maladaptive sustained attentional avoidance. The central objective of the proposed study was to examine the effect of a new AB modification design that addresses multiple components of AB among individuals with elevated social anxiety.

Study Aims

The present study was conducted to test three different AB modification conditions: 1) Extended Disengagement Training (xEDT), 2) Early-Late Combined Training (EL), and 3) Placebo Control (PLT). The extended disengagement condition was modeled from the existing AB modification paradigm (i.e., disengagement training) in which an individual's attention is guided away from threat via probe placement (i.e., the probe mostly/always appears in the location of the neutral stimuli trails). The combined early and late training condition is a novel AB modification design that is intended to further enhance the effect of the existing disengagement paradigm by providing additional training during late attentional avoidance. Therefore, attention is guided away from threat at early stages (i.e., 500 ms) and guided towards threat at later stages (e.g., 3000 to 5000 ms.). A placebo training condition presented probes, with equal frequencies (i.e., 50%), in both target locations. Thus, an individual's attention was not trained in any specific direction.

The proposed study design helps to answer some important questions. First, novel to the AB modification literature, we sought to answer whether the effect of AB modification focused on disengagement from threat can be further enhanced by the addition of a late-training component focused on reducing attentional avoidance at later processing stages. Second, the addition of the placebo control condition allowed us to test whether changes in AB are likely a function of treatment effect rather than effects of various non-specific or irrelevant factors (e.g., expectation, regression toward mean). Third, varying the duration of stimulus presentation in the context of AB modification would help clarify ambiguity about AB theories (i.e., disengagement difficulty, facilitated attention) for the attentional biases in SAD.

The main objective of the study was to examine whether the established AB modification procedure can be further enhanced by incorporating the attentional avoidance at later stages of cognitive processing into training. To achieve this objective, we tested the following hypotheses:

H1: At the early stage of processing (i.e.,500 ms), we predicted that individuals in the EL and xEDT groups would, similarly, show greater reductions in AB to threat than individuals in the PLT group. At later stages of processing (e.g., 3000 ms, 5000 ms). We predicted that individuals in the EL group would show greater reductions in attentional avoidance to threat than individuals in the xEDT and PLT groups.

H2: The EL condition would show a greater level of improvement in SAD and its related clinical symptoms relative to the placebo condition, with the xEDT falling in between.

H3: Reductions of AB to threat would be associated with reductions in clinical outcome (e.g., LSAS, SPIN).

Method

Participants

An analog sample of 82 college students who reported significant difficulties related to social anxiety were recruited via the UWM SONA system. Individuals were administered a brief online consent form and a brief 3-item social anxiety screening measure (i.e., Mini-SPIN). Those who scored 4 or above on the Mini-SPIN were invited to the full eligibility assessment.

Inclusion criteria were as follows: (a) between 18 and 60 years of age, and (b) elevated social anxiety symptoms (Mini-SPIN ≥ 4). Exclusion criteria were as follows: (a) current substance use disorder, (b) current or past organic mental disorder, bipolar disorder, schizophrenia, (c) severe attention difficulties, (d) significant suicidal ideation attempts during the past 12 months, (e) current treatment for social anxiety, and (f) change within the past month or plan to change medication during the study period

Written informed consent and a full-eligibility assessment were completed in-person. To screen for current and past psychiatric history, an independent evaluator administered the Mini International Neuropsychiatric Interview version 6.0 (M.I.N.I.; Sheehan, Janavs, Harnett-Sheehan, & Gray, 2010).

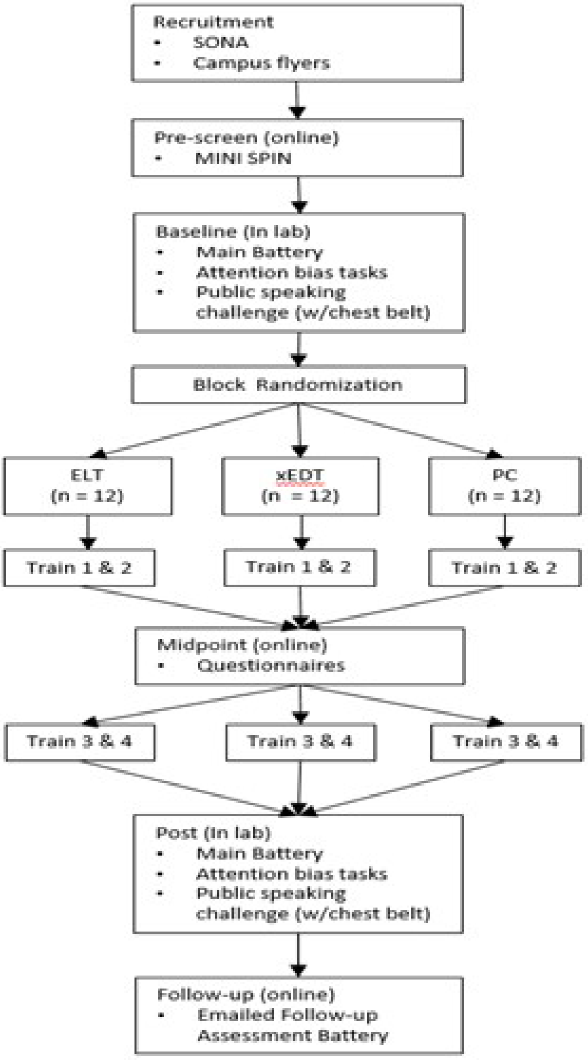

Figure 3. Participant study flow.

Procedure

Eighty two individuals completed a full-eligibility assessment, with 15 individuals being excluded for not meeting criteria. Thus, 67 individuals were randomized to a training condition and completed a baseline assessment that included a battery of questionnaires, an eye-tracking task, and two spatial cueing-tasks. This procedure was repeated at 1-week post treatment. At 1-month follow-up, participants were sent the questionnaire battery used at baseline- and post-assessment. During the active training phase, participants were asked to complete two AB training sessions during the first week. Then, a mid-point assessment (i.e., LSAS) was sent prior to completion of training session 3 and 4. Once all trainings were completed, participants were contacted for an in-person post-assessment. Participants who completed the study were awarded extra credit, and an additional $10 Amazon gift card was given to participants who completed the one-month follow-up. (See Figure 3 for participant study flow.)

Table 1.

Demographic Information

	Mean	SD
Age	24.17	7.37
Sex	**n**	
Male	7	
Female	26	
Education	**n**	**%**
High School Diploma	3	9.1
Some College	28	84.8
Bachelor's Degree	2	6.1
Income	**n**	**%**
Less than $10,000	10	30.3
$10,001 to $20,000	4	12.1
$20,001 to $30,000	6	18.2
$30,001 to $50,000	4	12.1
$50,001 to $100,000	7	21.2
Over $100,00	2	6.1
Race/Ethnicity	**n**	**%**
White	24	71
Black/African Americar	2	6
Hispanic/Latino	5	15
Other	3	8
Current/Past Treatment	**n**	**%**
Yes	13	39
No	20	61

Note. The demographic information includes participants who completed post-assessment.

Participant retention (48%) was lower than expected. Of the 67 individuals randomized to a training condition, 33 completed the post assessment and 19 completed the 1-month follow-up (see Table 1 for demographic information of the final sample). However, much of the attrition can be attributed to participants who were randomized to a training condition but never initiated training. Considering participants who completed at least one training, attrition rates were as follows: EL (10 of 13 remained at post), xEDT (10 of 13 remained at post), and PLT had the highest amount of drop out (12 of 22 remained at post). Although exit interviews were not conducted, some attrition was likely due to difficulty in recruitment of undergraduate students for a longitudinal study. A majority of the participants who dropped out of the study did not complete the remaining training session before the close of the semester. Nevertheless, only one participant correctly identified condition (correctly identified: xEDT = 1, EL = 0, PLT = 0); therefore, it is unlikely that the higher rate of drop out among PLT was a function identification of enrollment in the placebo condition.

Materials

Screening materials. The Mini International Neuropsychiatric Interview (M.I.N.I.; Sheehan et al., 1998) was developed by psychiatrists and clinicians in the US and Europe to assess for DSM-IV and ICD-10 psychiatric disorders (Lecrubeir et al., 1998). The M.I.N.I. is a semi-structured interview that takes approximately 15 to 20 minutes to complete, which is ideal for research purposes. The M.I.N.I. has demonstrated excellent test-retest and interrater reliability (Lecrubeir et al., 1998).

AB assessment instruments.

Spatial-cueing task. The modified spatial cueing task (Fox et al., 2001) was one method used to examine AB at pre- and post-treatment using two separate tasks - one with faces and one with words. Facial stimuli for the spatial cueing task were taken from Matsumoto and Ekman (1989) and contained models that were different from those used for the attention training tasks. The set included 12 models (6 men and 6 women) who displayed a disgust or neutral facial expression. We chose disgust as the valenced emotion given its strong association with SAD. The photos were digitized to an approximate height of 3.25" and width of 2.5". Each trial presented the face of one model varying in location (top/bottom) and expression (disgust/neutral). The words used for the spatial cueing task were selected based on their relation to SAD (e.g., shy, mock) or to a neutral stimuli (e.g., barrel, furniture). In total, there were 24 threat-related words and 24 neutral words. Words were counterbalanced to location (top/bottom).

For both the faces and words spatial cueing task, a fixation cross (+) appeared in the center of the screen prior to stimuli presentation. After 500 ms, a stimulus appeared in one of two spatial locations, centered vertically on the computer screen. Stimuli were presented for 1 s or 2 s, and were followed by a target probe (F/J) that appeared in one of the two locations. There were 240 trials (120 threat-neutral pairs and 120 neutral-neutral pairs), of which 120 were valid trials (target probe replaces the location of the stimuli) and 120 were invalid trials (target probe replaces the location opposite of the stimuli). Two indices of AB were calculated: facilitated attention (i.e., vigilance) to threat and difficulty in disengagement from threat. *Facilitated attention to threat* was calculated by subtracting the mean reaction time for valid-threat trials from the mean reaction time of valid-neutral trials. A positive value suggests greater attention to emotionally threatening cues relative to neutral cues. *Difficulty with disengagement* from threat was calculated by subtracting the mean reaction time for invalid-neutral trials from invalid-threat trials. A positive value represents a greater level of difficulty disengaging from threat cues relative to neutral cues.

***Eye tracking task*.** To ensure reliability and validity of eye-tracking results, a calibration test was completed prior to assessment of AB. Calibration was assumed when variance was less than 1° on the y- and x-axes. During the eye-tracking task, participants were presented with combinations of facial expressions (e.g., anger, disgust, neutral, happy) by the same model. There were 10 models, and each model was presented once (i.e., 10 trials). The pictures used for the task were taken from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert; 1999) and digitized to a width of 2.75", a height of 4.25". Prior to each trial, a fixation cross (+) was presented in the middle of the screen for 500 ms. Four pictures were presented simultaneously in a 2 (left/right) x 2 (above/below) format, and each trial is presented for 30 s. Data were recorded with SensoMotoric Instruments (SMI) iView X infrared pupil and corneal reflex imaging system. SMI iView X sampled data at 60 Hz and recorded two types of visual attention, fixations and saccades. A fixation is defined as a period (e.g., 200 ms) in which visual gaze is maintained on a single location. Saccades are defined as the rapid motion of the eye from one fixation point to another.

Eye-tracking data comes in many forms. However, for the present study, we analyzed entry time (i.e., the amount of time taken for the individual to engage in the area of interest for the first time in each trial; faster entry time can be interpreted as an index of vigilance similar to the attentional engagement index from the cueing task) and dwell time and fixation counts (i.e., the average duration and frequency of the total fixation concentrated within the interested area) in order to examine the study hypotheses. First, an area of interest (AOI) was established for each stimulus. An AOI is a defined rectangular area that is placed over a portion of the stimuli. In the present study, each facial stimuli represented the AOI (i.e., each face was an AOI). There were four primary facial emotions (i.e., neutral, disgust, sad, angry). Given that our attention training program was designed to ameliorate AB to disgust, and because disgust is the emotion most closely associated with SAD, we only compared the gaze data for disgust (threat) and neutral (emotional control stimuli). We calculated four eye-tracking indices: (1) Average Entry Time – average time before the first fixation within the AOI of disgust face, (2) Average Dwell Time – the average amount of time fixated within an AOI, (3) Average Glance Count – the average number of glances (saccades coming from outside of the AOI, also called ‘visits,’ and (4) Average Glance Duration – average dwell time plus the duration of saccade entering AOI. For analyses, we computed attentional engagement (disgust – neutral) and disengagement difficulty scores (neutral – disgust) for each of eye-tracking indices except average entry time.

Primary and Secondary Outcome Measures

Liebowitz Social Anxiety Scale (LSAS-SR; Liebowitz, 1987). The LSAS is a 24-item measure that taps into fear and avoidance in social and performance situations during the past week. Originally designed as a clinician-administered measure (LSAS-CA), the self-report version (LSAS-SR) is identical except that the participant reads the items instead of being asked by an experimenter. Fresco and colleagues (2001) reported similar internal consistency for the LSAS-CA and LSAS-SR, $\alpha = .92$ and $\alpha = .94$, respectively. The agreement between LSAS-CA and LSAS-SR subscale scores ranged from .56 to .98 among individuals with and without social phobia.

Social Phobia Inventory (SPIN; Connor, Davidson, Churchill, Sherwood, Weisler, & Foa, 2000). The SPIN is a 17-item instrument designed to assess aspects of social anxiety. This measure was developed with a sample of 353 individuals from five different groups. Internal consistency was adequate to excellent among groups ($.70 < \alpha < .94$), and the SPIN total score converged with the Brief Social Phobia Scale (BSPS; Davidson et al., 1997), $r = .57$, $p < .001$, and Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987), $r = .55$, $p < .001$.

Brief Fear of Negative Evaluation Scale (BFNE; Leary, 1983). The BFNE is a brief, 12-item version of the Fear of Negative Evaluation (FNE) Scale. The BFNE uses a 5-point Likert-type scale with 1 (*not at all characteristic of me*) and 5 (*extremely characteristic of me*). The BFNE demonstrated a high correlation with the FNE among undergraduate students (r = .96), as well as high internal consistency (α > .90) and 4-week test-retest reliability (r = .75) (Leary, 1983a; Miller, 1995).

Depression, Anxiety, and Stress Scales (DASS; Lovibond, & Lovibond, 1995). The DASS is a 42-item self-report measure of one's emotional functioning over the past week. Each item is answered with a 4-point Likert scale. Normative data were conducted with 2914 adults in Australia. Internal consistency was good to excellent in the normative sample, depression scale (α = .91), anxiety scale (α = .84), and stress scale (α = .90).

AB Training Conditions

Block randomization was used to limit the amount of variation between pre-treatment AB within conditions. Thus, attentional biases scores at 500 ms were used to as the measure of block randomization.

The attention training procedures for the current study were modified from an AB modification study by Amir and colleagues (2009). In that study, the dot probe paradigm was used to train attention away from threat at early stages. In the present study, participants completed 160 trials that varied in duration of stimuli presentation (500 ms to 5000 ms), probe type (E/F), facial expression (disgust/neutral), and model sex (male/female). The pictures used in the present study were taken from Ekman and Friesen (1976) facial stimuli set. This stimuli set included 10 models (5 male and 5 female) who expressed 6 different emotions (i.e., angry, sad, disgust, fear, happy, and surprise). A neutral picture of each model was also included. The pictures were digitized to a width of 1.5", a height of 2", and presented one above the other in the center of the computer screen.

Across conditions, each trial began with a fixation cue (+) located in the center of the computer screen. After 500 ms, the stimuli were presented and remained on the screen for the duration of the trail. Thus, when the target probe (E/F) appeared, it was juxtaposed onto the stimuli (i.e., on the forehead of the model).

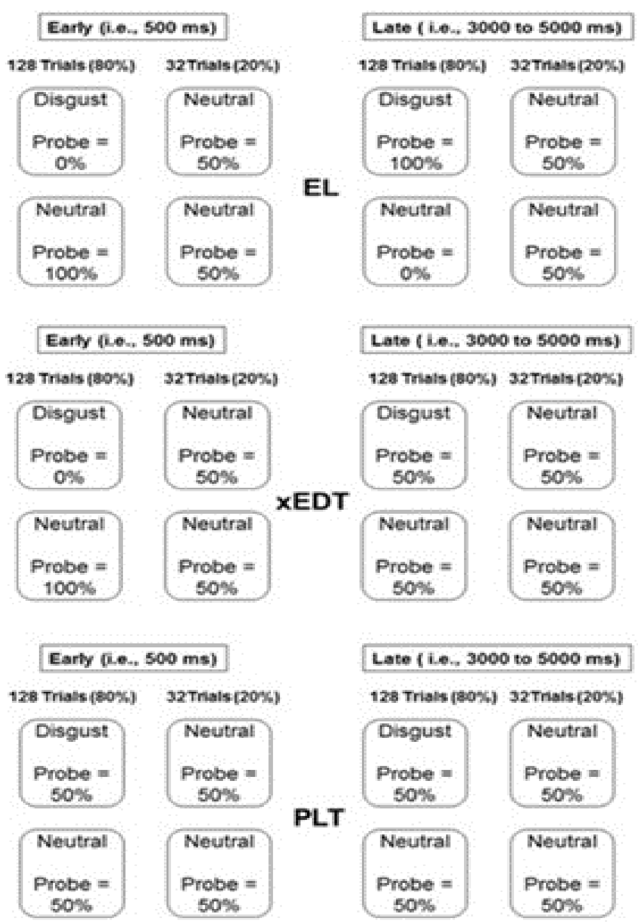

Figure 4. Attention modification trials by condition.

Early-Late Training (EL Training). Individuals were presented with 128 trials (80%) that directed attention away from threat at the early stage (500 ms). At later stages (3000 ms to 5000 ms), attention was directed toward threat within the same trials. The remaining 20% of trials at early and late stages contained neutral-neutral pairs. The early stage component of this condition was similar to existing AB modification procedures (Amir et al., 2008). Novel to current AB modification procedures, attention was directed towards threat at later stages of processing.

Extended Early Disengagement Training (xEDT) Training. Individuals were presented with 128 trials directing attention away from threat at the early stage (500 ms). At later stages (3000 ms to 5000 ms), of these 128 trials, 50% directed attention towards threat and 50% direct attention away from threat. The remaining 20% of trials were neutral-neutral pairs. The early stage component of this condition was similar to existing AB modification procedures (Amir et al., 2009). Placebo controls were implemented for later stages to ensure, as much as possible, that only early stages of AB were affected and that xEDT is comparable to EL in terms of the duration and dosage of training. This allowed for the investigation of whether the addition of late training towards threat (EL training) enhanced current AB procedures, relative to the xEDT condition.

PLT Training. Individuals were presented with 128 trials that directed attention, equally, towards threat and away from threat at the early stage and later stages. The remaining 20% of trials included neutral-neutral pairs. This condition was necessary to demonstrate that any changes in AB, at early and late stages, among those in the EL and xEDT conditions were presumably a function of treatment effect.

Analytic Approach

Multiple repeated measures (ANOVAs) were used to examine the relationship between changes in pre and post scores and relative contribution of training condition. Eta-squared effect sizes were computed as follows: $\eta^2 = SS_{effect}/SS_{total;}$ SS_{total} = the total sums of squares for all effects, interactions, and errors in the model. Interpretation of effect size estimates include small (.01), medium (.06), and large (.14). We also conducted a bi-variate correlation analysis to test the relationship between changes in clinical outcome and changes of AB index scores.

This study involved multiple comparisons, but Type I error corrections were not made. While a Bonferroni correction can guard against Type I error inflation, this analytic procedure reduces power and would make it more difficult to observe significant relationships (Moran, 2003). Given the small sample size and the need for a number of analyses in this preliminary study, Bonferroni corrections were not used.

Results

Thirty-two individuals (EL = 10, xEDT = 10, PLT = 12) completed all four attention training sessions and the post-assessment. AB indices were computed to test the study hypotheses. Attentional engagement and attentional disengagement scores were computed for each of the AB tasks (i.e., eye-tracking dwell time, eye-tracking glance count, curing task – words, cueing task – faces).

Hypothesis 1

A series of repeated measures analysis of variance (ANOVAs) were used to test the effect of training condition on changes in AB. Each analysis included an AB index score (i.e., engagement = disgust – neutral; disengagement difficulty = neutral – disgust) as the dependent variable and training condition entered as the fixed factor. The results suggest that there were no significant differences between training conditions across time, *ps* > .05 (see Table 2). Thus, our hypothesis that EL and xEDT would outperform PLT at early processing and EL would outperform xEDT and PLT at late processing was not supported.

Early Processing. There were no statistically significant differences between groups on reductions of AB to threat at early processing; however, the data trend suggests that those in EL showed the greatest overall reductions in early vigilance as measured by the average entry time to the disgust face, with xEDT coming in second and PLT showing the least reduction. The effect of training condition on average entry time to disgust face was small to medium ($\eta^2 = .04$). Attentional engagement scores

Table 2.

Raw Scores, Change Scores, and Repeated Measures ANOVAs of Clinical Measures and AB Indices

	EL (n = 10)		EDT (n = 9)		PLT (n = 9)		Time (F)	Sig	Int (F)	Sig	Int η2
	M	SD	M	SD	M	SD					
LSAS - Total							18.14	<.001	0.41	0.80	0.02
Pre	75.11	32.97	80.67	38.34	78.82	32.53					
Mid	70.44	30.14	75	38.67	74.73	30.71					
Post	54.56	28.65	65.78	41.49	65.36	34.37					
Change	20.55	4.32	14.89	-3.15	13.46	-1.84					
LSAS - Avoidance							17.50	<.001	0.73	0.73	0.03
Pre	36.11	17.55	38.22	19.65	38.27	17.33					
Mid	33.56	17.25	36.33	20.19	34.82	16.61					
Post	24.67	14.92	30.78	20.09	30.45	19.32					
Change	11.44	2.63	7.44	-0.44	7.82	-1.99					
LSAS - Fear							13.06	<.001	0.42	0.79	0.02
Pre	39.00	16.05	42.44	18.84	40.55	15.30					
Mid	36.89	13.74	38.67	18.76	39.91	14.36					
Post	29.89	14.29	35.00	21.79	34.91	15.80					
Change	9.11	1.76	7.44	-2.95	5.64	-0.5					
SPIN - Total							38.65	<.001	2.16	0.13	0.06
Pre	36.50	8.86	37.11	13.13	34.42	10.25					
Post	27.30	9.43	29.33	16.61	30.50	11.80					
Change	9.20	-0.57	7.78	-3.48	3.92	-1.55					
BFNE - Total							8.50	0.007	0.22	0.81	0.01
Pre	36.60	7.23	38.22	5.49	37.33	3.77					
Post	31.80	4.87	36.11	6.37	34.42	6.43					
Change	4.80	2.36	2.11	-0.88	2.91	-2.66					
DASS - Total							5.68	0.02	0.36	0.70	0.02
Pre	18.50	10.46	21.22	12.37	20.83	11.78					
Post	12.80	9.37	18.78	13.71	17.58	13.40					
Change	5.70	1.09	2.44	-1.34	3.25	-1.62					
DASS - Anxiety							6.47	0.02	0.964	0.39	0.05
Pre	6.60	3.81	7.11	4.76	5.75	4.10					
Post	3.50	2.72	5.22	4.71	5.08	4.56					
Change	3.10	1.09	1.89	0.05	0.67	-0.46					
DASS - Depression							2.82	0.10	0.45	0.64	0.03
Pre	5.60	5.32	7.78	6.94	8.00	7.07					
Post	4.80	4.94	7.33	7.30	6.25	7.20					
Change	0.80	0.38	0.45	-0.36	1.75	-0.13					
AB Vigilance Index (Neutral - Disgust: during the first 1,000 ms)											
Average Entry Time (into Disgust)							1.89	0.181	0.621	0.55	0.04
Pre	2223	1191	2020	1062	1985	803					
Post	3495	3263	2658	1531	1997	1103					
Change	-1272	-2071	-638	-469	-12	-300					
Average Dwell Time (ms)							0.02	0.89	0.65	0.53	0.05
Pre	33.78	119.2	-14.36	143.89	-46.29	126.68					
Post	41.26	102.84	-62.96	144.51	-17.22	41.52					
Change	-7.48	16.36	48.60	-0.62	-29.07	85.16					
Average Glance Count							0.001	0.976	0.08	0.92	<.001
Pre	0	0.19	-0.06	0.2	-0.08	0.15					
Post	0	0.18	-0.08	0.22	-0.06	0.11					
Change	0.00	0.01	0.02	-0.02	-0.02	0.04					
Cueing Faces 500 ms							0.02	0.89	0.26	0.78	0.03
Pre	105.19	37.3	102.12	15.8	110.15	19.1					
Post	107.65	27.9	109.93	17.2	103.5	22.8					
Change	-2.46	9.40	-7.81	-1.40	6.65	-3.70					
Cueing Words 500 ms							1.04	0.32	1.02	0.38	0.08
Pre	127.39	21.6	103.94	28.8	117.44	20.8					
Post	116.58	34.6	111.58	17.2	90.1	54.7					
Change	10.81	-13.00	-7.64	11.60	27.34	-33.90					
Late Disengagement Difficulty (Disgust - Neutral: during 3,000-5000 ms)											
Average Dwell time (ms)							0.01	0.93	0.53	0.60	0.04
Pre	132.9	191.1	6.38	322.3	-96.08	388.9					
Post	37.91	187.6	-10.2	341.5	-5.67	295.1					
Change	94.99	3.50	16.58	-19.20	-90.41	93.80					
Average Glance Count							0.72	0.4	0.49	0.62	0.04
Pre	0.04	0.2	0.11	0.3	-0.07	0.4					
Post	-0.06	0.2	-0.03	0.3	-0.03	0.3					
Change	0.10	0.00	0.14	0.00	-0.04	0.10					

Note. Results of repeated measures ANOVA with Time (pre AB index and post AB index) as the within subject variable and Condition as the between subject variable. The interaction term is Time x Condition.

(i.e., average glance count and average dwell time) from eye-tracking revealed a trending reduction in vigilance from pre- to post-treatment among those in the xEDT condition, followed by EL, and PLT showing the least improvement. The effect of training condition on changes in average dwell time was small to medium (η^2 =.05), and the effect for average glance count was less than .001. Attentional engagement scores from the words and faces cueing task showed that PLT had the greatest reductions in early vigilance followed by EL, and PLT falling in last. The effect size of condition on changes in words over time was medium (η^2 =.08) and for faces was small (η^2 =.03).

Late Processing. There were no statistically significant differences as a function of time, group, or the interaction between time and group. However, the disengagement difficulty index for average dwell time (i.e., average dwell time for disgust face – average dwell time for neutral face) trended in the direction such that EL showed the greatest reductions in AB, with xEDT showing second most improvement, and PLT coming in last, medium effect size (η^2 =.04). Results of the disengagement difficulty index for average glance count indicated that xEDT showed the greatest reductions in late avoidance, followed by EL and PLT, effect size was medium (η^2=.04).

Hypothesis 2

To test hypothesis 2 (i.e., the greatest improvement in clinical symptom reduction would be EL followed by xEDT and PLT), a series of repeated measures ANOVAs were conducted with training condition entered as the fixed factor and each of the clinical outcome variables entered as the dependent variable. Each of the clinical measures (i.e., LSAS, SPIN, BFNE, and DASS) showed a significant main effect of Time (pre and post). Across conditions, individuals reported significantly less clinical symptoms at post-assessment than pre-assessment. The group by time interaction was not statistically significant for any of the symptom measures (see Table 2).

There were no statistically significant differences between groups; however, the data showed a trend that EL outperformed xEDT and PLT on all clinical measures, which is consistent with the direction of the hypothesis. Changes in SPIN scores (η^2 = .06) indicated that those in the EL condition had a 30.8% reduction in symptoms, while xEDT showed a 21% reduction and PLT with 11.4% at post-training assessment. LSAS change scores (η^2 = .02) showed that those in EL reported a 27.4% reduction, followed by xEDT with 18.5%, and PLT with 17.1%. BFNE change scores (η^2 = .01) indicate that EL had symptom reductions of 13.1%, followed by PLT with 7.8%, and xEDT with 5.5%. Finally, DASS change scores (η^2 = .02) showed a trend in symptom reduction with EL reporting a decrease of 30.8%, with PLT reporting a decrease of 15.6% and xEDT showing a decrease of 11.5%.

Hypothesis 3

We conducted an exploratory evaluation of the relationship between reductions in AB and reductions clinical outcome. Symptom reduction scores on clinical measures were correlated with reduction scores of AB indices. Bivariate correlation analysis revealed a significant correlation between a reduction in early attentional engagement and an increase in SPIN score, (r = -.50, p = .017). No other correlations were significant; however, there were small to medium effects at both early and late processing (see Table 3). When examining changes in attentional engagement scores

Table 3.

Correlation Table for Change Scores of AB Indices and Clinical Measures

	AE change score for average glance count from 0 to 1000 ms	AE change score at 500 ms for faces and words	AD change score for average dwell time from 3000 and 5000 ms	ADchange score for average glance count from 3000 to 5000 ms	SPIN Change	LSAS Change	LSAS Fear Change	LSAS Avoid Change	BFNE Change	DASS Change
AE change score for average dwell time from 0 to 1000 ms	.886**	0.12	-0.13	-0.09	0.30	0.12	0.17	0.05	0.08	0.04
AE change score for average glance count from 0 to 1000 ms		0.04	-0.12	-0.07	0.32	0.28	0.32	0.21	0.25	0.19
AE change score at 500 ms for faces and words			-0.24	-0.16	-.501*	-0.01	-0.19	0.16	-0.12	-0.07
AD change score for average dwell time from 3000 and 5000 ms				.796**	0.03	0.20	0.16	0.22	-0.16	0.04
AD change score for average glance count from 3000 to 5000 ms					-0.04	-0.06	-0.09	-0.03	-0.18	-0.13

Note. *p<*.05,* **p<*.01*

for average dwell time and average glance count, the data suggest a positive relationship between changes in SPIN scores, (*r* = .30 and *r* = .32, respectively), LSAS scores, (*r* = .12 and *r* = .28, respectively), and DASS scores (*r* = .04 and *r* = .19, respectively). The relationship between changes in attentional engagement for cueing and clinical measures was less clear. At late processing, reductions of disengagement indices for dwell time showed a small relationship with changes in LSAS (*r* = .20).

Discussion

The present study was conducted to evaluate whether the addition of a late training component would enhance an established AB modification training program (Amir et al., 2003) that aims to reduce vigilance engagement with threat at early attentional processing. We hypothesized that there would be a significant difference between conditions on indices of AB and clinical measures. More specifically, the EL condition would show the greatest improvements on AB indices and clinical measures, with xEDT outperforming PLT. We also hypothesized that reductions in AB indices would be associated with reduction in clinical outcome. Results did not support the study hypotheses. However, an examination of effect sizes and symptom reduction rates revealed trends partially supporting our hypotheses. For instance, on all clinical measures, EL showed greater symptom reduction than xEDT and PLT, and xEDT and PLT showed similar reductions across measures.

At early stages of processing, the data showed a trend that the addition of the late-training component enhanced the efficacy of early attention training. Those in the EL condition showed the largest decrease in average entry time (i.e., the degree of early vigilant engagement with the threat) to disgust face (i.e., slower to enter AOI), than xEDT who improved the second most, and PLT who saw almost no change from pre to post. Results of engagement scores for dwell time and glance count showed that xEDT outperformed EL and PLT. Finally, attentional engagement scores from the spatial cueing tasks (words and faces) showed that PLT had the greatest reductions, followed by EL and xEDT. Taken together, these results may suggest the spatial-cueing task and eye-tracking are measuring different aspects of attentional engagement. At later stages of processing, the attentional disengagement index (i.e., greater dwell time on disgust vs. neutral face) was reduced the most in the EL group, followed by xEDT and PLT. This provides support that the additional attention training toward disgust at later-stages of processing may help reduce difficulty in disengaging from threat. The exploratory analysis of the relationship between changes in AB and changes in clinical measures revealed small to medium effect sizes. Thus, while not statistically significant due to low statistical power, there were general trends showing that changes in AB were positively associated with changes in clinical outcome. This result is consistent with previous research demonstrating this relationship (e.g., Clarke et al., 2014).

The implications of the current study are important in several ways. First, this appears to be the first study to investigate AB modification at stages of attention processing greater than 1500 ms. We found a non-significant trend that EL outperformed xEDT and PLT on all clinical measures, but with small to medium effect sizes. Furthermore, the addition of the late-training component appeared to enhance the existing AB modification training focused on enhancing disengagement from threat at early stages. Those in EL showed a reduction in early engagement as measured by average entry time (ms). However, average dwell time and average glance count data suggest that xEDT showed greater improvement than EL and PLT, with EL falling in between. Thus, those in EL showed greater avoidance to disgust for the first fixation; however, once fixated they remained longer than xEDT. Cueing AB indices suggest that PLT outperformed EL and xEDT. This result may indicate that AB functions differently across different task demands. The late-training component also showed promise in the reduction of late-stage disengagement difficulty. Those in EL showed greater reduction than xEDT and PLT.

We found a trend that supports the benefit of adding late-stage AB training. There is an extant gap between the AB literature and the AB modification literature. The AB literature has provided some important evidence for the vigilance or vigilance-avoidance pattern of AB (e.g., MacLeod & Mathews, 2012); however, this is likely an oversimplified pattern to explain AB. This is evidenced by a recent study that examined

AB among individuals with high-trait anxiety (Zvielli, Bernstein, & Koster, 2014). The researchers examined AB on a trial-by-trial basis, rather than collapsing reaction times over trials at a group level, and found that the levels of AB are characterized by a significant temporal variation, which is more pronounced among anxious individuals relative to healthy controls. Therefore, the scope of AB modification should be expanded beyond the narrow range of earlier attentional processing (i.e., 500 ms). Further, introducing an AB modification component at different time points, does not seem to conflict or interfere with benefits of early-stage attention training. Thus, it is warranted to explore variations of AB modification, even if the conditions seem to contradict each other. It is possible that we may observe additive effects rather than cancelation.

We also found a general trend showing reductions in AB were related to reductions in clinical measures. For instance, we found a positive relationship between changes in AB indices and changes in social anxiety symptoms. This is consistent with previous research that shows a robust relationship between reductions in AB and reductions in social anxiety symptoms (Amir et al, 2009, Schmidt et al, 2009). Thus, AB may be an important underlying cognitive mechanism of social anxiety. When AB is reduced, so too are anxiety symptoms (Clarke et al., 2014). Further research should be done to examine specific cognitive mechanisms that may differentially mediate the effects of various AB modification programs. The present study was too small to run such an analysis; however, a future study with a larger sample size will be capable of testing this model. It is possible that in xEDT, the mediator may be a reduction in early disengagement (reduction in attentional vigilance at early stages), but in EL the effects may also be impacted by late attentional change (e.g., reduction in maladaptive attention processes such as excessive vigilance or avoidance at late stages). We observed reductions in disengagement difficulty for those in the EL condition. This finding could be argued to represent avoidance which should have been reduced by the training. Or, it may be possible that any training component at late stage will help reduce either excessive vigilance or avoidance. This will be an important area of future research.

Future research is also needed to expand our understanding of AB at different stages of processing, because there is no clear standard as to what constitutes ‘early’ training and ‘late’ training. Most AB modification research has been conducted at 500 ms, which is considered early processing. Koster and colleagues (2010) tested AB modification at 30 ms, 100 ms, and 1500 ms. In their study, they define early processing as 30 ms and 100 ms, and late process was defined as 1500 ms. Koster and colleagues found support for AB modification at 1500 ms. While we did not find statistically significant differences between training conditions, the trends of the data are consistent with earlier research showing that AB modification at later stages of processing is possible (Koster et al., 2010). Thus, future research should examine the AB modification paradigm to systematically test the boundaries of ‘early’ and ‘late’ AB modification training. We operationally defined 500 ms as early processing in the cueing task, and 0 to 1 s in with eye-tracking indices. While we targeted late-AB between 3000 and 5000 ms, these time segments may not reflect the full trajectory of AB. However, this is a preliminary study and it is possible that late training could be potentiated by extending to a longer duration (e.g., 10 s, 30 s). Given that socially anxious individuals are often faced with interactions that last longer than 5000 ms, it is reasonable to consider AB modification at longer durations. Further consideration is warranted to optimize AB modification procedures. We found discrepancies between eye-tracking indices and spatial-cueing indices. This may be because of the measurement differences. Cueing data provides a snap-shot (e.g., 100 ms, 500 ms) view of visual attention, whereas eye-tracking indices measure a more continuous flow of visual attention. Due to their significant methodological differences, direct comparison and interpretation of results is difficult. Taken together, there is still much to learn about AB modification, and it is imperative that researchers develop ‘gold standard’ measures of attentional engagement and attentional disengagement with cueing data, and attentional avoidance with eye-tracking data.

Limitations

There were several limitations of the present study. The sample size was small; although approximately 50% of the participants withdrew from the study prior to the post-assessment. The present study also utilized an internet-delivered approach. Two previous internet-delivered AB modification trials have failed to find support for AB modification efficacy outside of controlled laboratory settings (Boettcher et al., 2011; Carlbring et al., 2012). The present study also used repeated measures ANOVAs to analyze only pre- to post-training data because of the large attrition in the follow-up assessment. It would be useful to analyze the data including follow-up data, using a multi-level modeling approach that can handle the missing values in a longitudinal study more efficiently.

Conclusion

The present study was a randomized-controlled trial to test whether an additional late-stage AB modification training component could improve the efficacy of existing AB modification intervention. The small sample size limited statistically significant findings; however, several trends with small to medium effect sizes suggest that late-stage AB modification may enhance existing AB modification intervention.

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